'09/806720

JC02 Rec'd PCT/PTO 0 4 APR 2001

VALVE TRAIN ASSEMBLY

The present invention relates to a valve train assembly for an internal combustion engine, and to rocker arms for such an assembly. The invention is particularly but not exclusively related to arrangements in which the number of parts in the assembly is reduced, in which various parts can be pre-assembled to facilitate engine assembly, and in which various parts are made more simply.

Various aspects of the invention are intended to deal with a number of separate problems in existing arrangements. For example, internal combustion engines which have a plurality of valves for each cylinder tend to use rocker arms which are mounted on a common pivot or axle and which therefore need to have differing lengths in order to match the differing positions of the valves. It is therefore necessary to manufacture two different types of rocker arms.

It is also common, particularly for centre-pivoted rocker arms, to have an hydraulic lash compensation device mounted at the valve end of the rocker arm, the device therefore being continually reciprocated. This requires a complex machined oil distribution path and makes it more difficult to feed oil to the lash adjuster. Furthermore, the components of the rocker arm are heavy and therefore strong valve return springs are required, and the rocker shaft has to be strong and therefore of large diameter, and heat-treated to harden the surface in order to resist wear.

Various aspects of the present invention are set out in the accompanying claims.

In a preferred embodiment, a valve train assembly for a internal combustion engine comprises a valve train carrier having a plurality of individual rocker arm fulcra, and a rocker arm attached to each fulcrum. The carrier may also have one or more camshafts mounted thereto.

Such an arrangement can be provided as a pre-assembled unit for fitting to a cylinder head having valves mounted therein, thus substantially facilitating the assembly of an engine.

Each fulcrum may form part of a hydraulic lash adjuster. Accordingly, since the lash adjusters would be fixedly mounted to the carrier, they are more easily supplied with oil, so that a smaller oil pump producing relatively low pressure can be used.

In a particularly advantageous arrangement, each rocker arm and its associated fulcrum have co-operating part-spherical surfaces which permit not only the pivoting motion required for operating the valves, but also a degree of rotation about the length of the rocker arm, to provide a self-adjusting function. Preferably, the rocker arm has a part-spherical recess into which a part-spherical projection is located. (In practice the profile of the recess may comprise several, e.g. three, spherical segments of slightly different diameter tangential to each other, sometimes referred to as a gothic socket.) The rocker arm may be attached to the projection by means of a clip, possibly made of spring steel, which is fitted over the head of the projection. As the rocker

arms do not need to be fitted to rocker axles, they may be made smaller and lighter compared to existing aluminium or steel rockers. In a preferred embodiment, the rockers are made of pressed sheet metal (with the final thickness possibly increased or decreased by the pressing operation to provide suitable weight/strength properties), and their lightness enables the use of lighter valve springs resulting in lower energy consumption.

Because of the self-adjusting arrangement mentioned above, it is possible to arrange for contact between a driving cam and the rocker arm to extend laterally over a large distance, for example by having mounted on the rocker a roller with a wide surface which is flat in a direction parallel to the roller axis. This provides a greater area of contact than existing rockers which rotate about an axle, and which need a roller having a convex surface to ensure proper contact. As a result of the reduction in stress by increasing the area of contact, the camshaft need not be so strong, and indeed it is possible to use cast iron instead of more expensive steel.

By appropriate positioning of the individual rocker arm fulcra, it is possible to use rockers of equal length for all the valves. Accordingly, the rockers can be substantially identical, thereby reducing manufacturing costs.

Arrangements embodying the invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a side view of a prior art rocker arm;

Fig. 2 is a side view, partly in section, of a rocker arm arrangement according to the invention applied to a valve;

Fig. 3 is a side view of the rocker arm of Figure 2;

Fig. 4 is a plan view of the rocker arm shown in Fig. 3;

Fig. 5 is a section along the line V-V of Fig. 3;

Fig. 6 shows is a section along the line VI-VI in Fig. 3;

Fig. 7 is a section through a hydraulic tappet forming a fulcrum of the rocker arm;

Fig. 8 is a transverse section showing a valve train carrier of the present invention, for controlling two rows of valves with a single central camshaft;

Fig. 9 is a plan view of the valve train carrier as shown in Fig. 7;

Fig. 10 is a side view showing another embodiment of a valve train assembly in accordance with the invention; and

Fig. 11 is a perspective view, from below, of a valve train carrier of the assembly of Fig. 10.

Fig. 1 shows a prior art rocker (B') made of pressed aluminium, and comprising a lever of the first order mounted on a fixed axle (70), which also carries other rockers arranged in a row. One end of the rocker (B') is in

contact with a cam (C) by means of a roller (R'), while the other end has a reciprocating and pivoting hydraulic lash adjuster, referred to also as a tappet (80). The tappet has a spigot or projection (81) at the base acting on the head of a valve (V). A double row of camshafts (A') acts on convex surfaces of rollers (R').

Fig. 2 shows an example of a rocker arm arrangement according to the present invention.

The rocker (B) of the present invention is again a lever of the first order, i.e. it is a centre-pivoted rocker arm. However, the rocker (B) is mounted on a tappet (4) placed between a first end of the rocker (B), which is fitted with a roller (R) displaced and pushed against a cam (C) on the camshaft, and a second end, which transmits the pressure to open the poppet valve (V) against the resilient force of a spring (M).

The rocker (B) shown in Figs. 3 to 6 is made up of two lateral flanges (12) and (12'), linked by an upper plate (13), with which it forms a U-shaped section, and is formed by bending or stamping a sheet of steel.

In the process of pressing the rocker from sheet steel, a hemispherical recess (14) is formed in the plate (13), suitable for mating with the hemispherical head (41) of a spigot or projection (42) which is part of a lash adjuster or tappet (4). The tappet (4) is fitted in its own fixed seat (45, Fig. 7) formed by boring an aluminium cover (L) of the engine head. The cover (L) constitutes a valve train carrier, and is discussed further below.

Because of the co-operation of the part-spherical surfaces of the recess (14) and the end (41) of the spigot (42) this spigot forms a fulcrum about which the rocker arm (B) can reciprocate in order to operate the valve (V), and around which the rocker arm may be laterally turned. It will be noted in particular that the rocker arm can rotate about an axis X (Fig. 4) and about the axis of the spigot (42), to provide a degree of self-adjustment for the purposes set out below.

Rocker (B) comprises at one end a transverse opening (15) into which a pivoting trunnion (16) is fitted, the trunnion (16) having opposing recesses (17), one of which presses onto the head of the stem of the valve (V), adjusting itself in accordance with the relative movement of the rocker arm (B) of the valve shaft, which may vary depending on the type of engine.

At the other end is fitted roller (R) having needle bearings and located on an axle (20) extending through openings (22) provided in flanges (12) and (12').

Roller (R) is very simple, with a straight cylindrical outside surface which closely fits the outside surface of cam (C) since as described above the rocker, with its fulcrum on the hemispherical recess (14), automatically compensates for any imperfection in transverse movement, thus making a convex outside surface, as required in customary design, unnecessary.

In order to keep the trunnion (16) fixed in place at the first end of the rocker, a resilient sheet (25) is used with flanges (26) folded back on themselves so that the lower section can be attached to the rocker flanges (see

Fig. 5). The resilient sheet has an inlet (27) at the top for the purpose of lubricating the trunnion (16).

A second resilient sheet (30), with flanges (31) folded back on themselves, is fitted over the hemispherical recess (14) to restrict relative transverse movement of the spigot (42) of tappet (4). The sheet (30) may be made of spring steel, and has an aperture which allows the rocker arm (B) to be easily snap-fitted over the head (41) of the spigot (42) and thus attached to the cover (L). The sheet (30) thus retains the rocker arm (B) on the cover (L) without inhibiting any intended operational movement of the rocker arm.

In this embodiment, the projection or spigot (42) has a relatively narrow neck leading to the enlarged, part-spherical head (41), so that the aperture in the sheet (30), which has a diameter slightly larger than that of the neck, can be used to hold the rocker arm in place. Preferably, as shown in Fig. 4, the aperture is elongate, with its longitudinal axis extended substantially parallel to the length of the rocker arm, so as to facilitate fitting the rocker arm to the tappet (4), and to permit a degree of freedom of movement in the longitudinal direction to ensure proper engagement with the cam shaft and valve. However, alternative arrangements are possible. For example, the rocker arm could be fastened to the head (41) by means of a rivet or other member extending through the rocker arm into a recess at the end of the head (41), possibly engaging therein by means of a screw thread or by a

resilient enlarged portion which engages in an annular ridge within the recess. In any event, it is desired that the means attaching the rocker arm to the fulcrum be fairly loose, and arranged so as not to inhibit the intended operational movement of the rocker arm.

Fig. 7 is a detailed view of the tappet (4), which keeps rocker (B) pressed against one end of the valve head (V) by means of the pivoting trunnion (16), and at the other end against the cam (C) by means of roller (R). The spigot (42), carrying the hemispherical head (41) which forms the rocker fulcrum, forms a plunger which is attached to a chamber (43) which slides in a sleeve (44) inserted precisely into the seat (45) formed by boring in the cover (L) of the engine block. Within the lower part of the chamber (43) is a high pressure tappet chamber (47), whilst above is a plunger (48) which houses a low-pressure oil reservoir (49). The oil is supplied through the inlet (50) and channels (51) in the cover (L).

Inlets (46) and (46') are provided in the spigot (42) for the purpose of lubricating the hemispherical end (41) which acts as the fulcrum.

By way of example, Figs. 8 and 9 show from the side and from above, respectively, the arrangement of a valve control train using rockers (B1), (B2), ... as described above, for operating valves V1, V2, ... in an internal combustion engine with a single central camshaft (A).

Using such an arrangement facilitates the assembly of an engine. The engine cylinder head has a lower head part (65) into which the valves (V1)

and (V2) are installed. Their springs (M) are located in recesses (60) of the lower head (65).

In a separate operation, the valve train carrier formed by the cover (L) has fitted thereto the rocker arms (B1) and (B2), together with any other rocker arms required for the engine (see Fig. 9). This therefore forms a self-supporting assembly which can be manufactured and sold separately from the rest of the engine and provided in a pre-assembled state ready for fitting to the engine. Thus, not only is the overall assembly facilitated by pre-assembling the valve carrier, but the individual fitting of the rocker arms can be carried out as a separate operation, so the final assembly of the engine is significantly simpler.

If desired, a manufacturer can supply different versions of the valve carrier, all for fitting to the same engine head, but made to different specifications. For example, one version may have hydraulic lash adjusters and rocker arms provided with rollers, and another, less-expensive one may have mechanical lash adjusters and a fixed cam-engaging surface on the rocker arms rather than rollers. This facilitates the production of different types of engines, suited to the customer, while still enabling a simple assembly procedure.

The location of the respective fulcra on the cover (L) can be selected such that all the rocker arms may have the same length, and therefore can if desired be constructed identically.

Preferably, the camshaft is also fitted to the cover (L) during pre-assembly.

Figs. 10 and 11, in which like reference signs represent like integers, show an alternative embodiment of the invention, in which twin camshafts (A1, A2) drive respective rows of rocker arms (B). The aluminium valve train carrier (L) is best illustrated in Fig. 11, which shows identical rocker arms (B) mounted in two lines, the arms within each line being positioned in a staggered arrangement so that they are suitably located for driving the inlet and outlet exhaust valves. Although not shown in Fig. 11, the camshafts (A1, A2) are also preferably mounted to the carrier (L) before the entire assembly is fitted to the lower cylinder head of the engine.

The carriers (L) of either embodiment may have channels for distributing oil to the valve trains; indeed, all the required oil channels may be located in the carrier.